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RESEARCH ARTICLE

A Revised Interpretation of Risk in Project Management

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Abstract

Both project management and finance have their own advanced risk concept, but developing a correct and complete integration of them has not been resolved so far. The novelty of the paper is a general framework for risk management in which the goals of a project are approached by the interests of owners rather than by the regular object-oriented ways. The framework resolves the following contradictions. 1) The traditional risk management approach distributes the total risk of a project among risk classes; as a consequence, the fact that only a fraction of the project risks are assumed by the owners is ignored. 2) Traditional project risk management cannot deal with the phenomenon that higher risks are found in the risk categories during the later periods of a project. 3) The positive deviation from the project goals is not interpretable in the traditional approach. In the new framework risk analysis becomes a more effective tool for all the participants of a project.

Keywords

project risk · project success criteria · financial risk management

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1 Introduction

A contradistinction of project risk management is that the owners' value-making approach in its full complexity is often lost on the level of operative management. The phenomena that managers tend to identify the owners' expectations as finishing the object of the project is obvious, as the purpose of their existence in the project company is tied to the object delivering process itself. The main problem is then that the 'harmful events' in operative risk management also tend to reflect to the events impeding the implementation goals of the project delivery, but not necessarily to the barriers of the value creating processes. In contrast, the owners may realize added value with significant delays and cost overruns, or even without finishing the project. According to this contradistinction there is a pressing need for the development of an integrated risk management method.

The novelty of this paper is a more general project definition for the field of project management where the well-known concepts of finance and the traditional concepts of project management are integrated into one framework. In this new framework, the minimum expectation (i.e. the project goal) of each stakeholder can be determined. This goal is financially connected to the interests of the participant's owners rather than to the object of the project itself. On the other hand, in the integrated framework a revised risk analysis is introduced as an effective tool to enable participants to structure their contracts during the conceptual phase to take only favorable risks and eliminate disadvantageous risks. The application of some well-known risk analysis techniques is also illustrated in the integrated framework.

After reviewing the relevant literature the paper follows a threefold structure. First, the paper provides a revised integrated project risk assessment framework enhancing the conventional risk category-based methods. Second, the minimum requirements of the owners are clarified to acquire the main goal of project risk assessment and to identify the harmful events jeopardizing this goal. Finally, the widely known risk assessment procedures are revised, and a methodology for taking and selecting proper risks is provided.

2 Literature Review

The general definition of risk in the project management context has undergone significant changes since the 1950s. At that time, risks were only regarded as the possible negative consequences of events or tasks (Rowe, 1977) and were analyzed in a quantitative and formal way (Nemeslaki, 2009). The project management literature concentrated on specifying the risk classes; thus, such research investigated how to manage risks based on those classes. Subsequently, the two-sided nature of risk was emphasized: positive consequences were also considered (Flanagan and Norman, 1993). To address this bilaterality, project management standards included the objective of maximizing the results of positive events and minimizing the consequences of adverse events. In accordance with these standards, many resources suggested methods for risk analysis that accounted for the probability and consequences of risks (PMI, 2013). Turner (2009) summarized the most relevant generic risk management processes and standards. Consequently, numerous industry-specific applications and research projects were established to enable the efficient management of risks (Bevilacqua et al., 2009; Chan et al., 2011; Kwan and Leung, 2011). Zhang (2011) provided an extensive literature review of two schools of project risk analysis based on their objectivity, taking the different risk definitions and methods into consideration. Eventually, risk in project management became increasingly understood conceptually as the likelihood of an event occurring within a project (Baloi and Price, 2003; Purnus and Bodea, 2013); however, an "event" continued to cover a wide range of meanings. The principal methods of risk measurement have gradually spread from other scientific fields to project management applications. (E.g. for a summary of the most frequently used methods in the construction industry, see KarimiAzari et al., 2011).

The literature on project management typically divides the risk management process into steps: risk identification (and classification), risk analysis (including qualitative, and, if it is necessary and possible, quantitative ranking) and response (reaction). Because the steps of risk management must be monitored in the course of the realization phase, some authors regard controlling or tracking as an additional risk management step (see, e.g., Al-Bahar and Crandall, 1990). PMI (2013) states that risk management planning should be done as an additional early step, even if most of the literature does not include and mention it.

This paper gives a brief survey on the risk classification methods, because the suggested model integrates and complements this point of the risk management process. There is a rather significant presence of the risk classification development phase of risk management in the literature. According to Flanagan and Norman (1993), risks should be classified based on their consequences, types and effects. From their perspective, risks can be separated into these three categories if the tool is the full-scale general system approach combined with the framework of the work breakdown structure (WBS). Chapman (2001) suggested that risks ought to be classified based on a different aspect: the place of occurrence. In this case, the classes are the environment, industry, client and project. Nevertheless, in the case of construction projects, Klemetti (2006) recommended the formation of external and internal risk source sets. The most widespread methods name the following risk classes, among others (Shen et al., 2001). The economic and political environment in which a project is realized provides the country risk. In some cases, political risk constitutes a separate category. Construction and scheduling risks involve time and cost overruns; problems related to technical, quality, design and environmental questions; permits; licenses; and acts of God. Technical risks often form an independent category. Exchange rate, inflation and interest rate risks belong to the class of financial risks. Changes in the environment and the accuracy of forecasts are regarded as business risks or market risks. The regulatory environment determines the legal risks. In addition, the team executing a project and the management methods could also involve risks that are referred to as management risks. Another branch of the research examines the human components of risk management and their effects. For example, Thevendran and Mawdesley (2004) divided the human factors that affect construction project risks into three groups. The individual level of human factors includes elements related to abilities, skills, knowledge, stress, motivation, and emotional and cultural characteristics. On the project team level, there are management, communication, and coordination tasks and control. The organizational level contains systems and procedures, organizational politics and norms.

The field of risk management has found its place and role in the project management processes, however, certain targeted empirical tests signal the possibility of serious fundamental problems. For instance, Uher and Toakley (1999) studied the implementation of risk management applications and tools and found that although most experts were familiar with the current concepts of risk management, they did not apply them in the initial phase of projects. Moreover, the authors found that risk identification is the best-known component of risk management, and the respondents showed a preference for using qualitative methods in risk analysis techniques. These authors also found that although information technology is widely used in the conceptual phase of a project life cycle, it is used primarily for cost estimating, scheduling and forecasting. They also observed a distinct lack of integration between information systems on average. These results show that although the most updated risk engineering techniques are available, their application and operation is still far from smooth. The root of this phenomenon is that the picture remains incomplete: the ultimate motivations behind risk management processes must be clarified. The literature often implicitly assumes that risk management can be interpreted as an engineering tool with processes that are bounded to the tangible product of a project (e.g., finding and managing causes which jeopardize completing the planned object). In most cases, even the more sophisticated risk management frameworks focus on engineering methods (Dikmen et al., 2008; Tserng et al., 2009) and fail to define the comprehensive goal of risk assessment. For example, it is irrational to discuss the well-known time overrun risk from the project owners' point of view if such risk does not involve a change in value for them, because e.g. lost money will be regained from a contractor in the form of a penalty payment. Certainly, time overrun would not be an important risk for the owners of contractors either if insurance covers the additional costs. In this case, the owners of the insurance company bear the risk.

Although Zavadskas, Turskis and Tamosaitiene (2010) already have identified a multi-attribute decision-making method taking the interests and goals of the stakeholders into consideration, the ranking of these goals, and the context among them, the risk analysis consequences expressed as functions have been left undefined.

3 Integrated Risk Assessment Framework

The problem with the conventional approach for project risks is that a manager may conclude with certainty that the ultimate aim of his or her company is to create the object of the project. However, in a carefully designed contract, the compensation that is paid in the case of the client's cancellation of the contract is often comparable to the profit that is made if the object of the project is created successfully. In such a case, the owners of the contracting company may not perceive the interrupted project as a failure. According to a generally accepted definition by Project Management Institute (2013), "a project is a temporary endeavor undertaken to create a unique product, service, or result." This definition implies that someone *wants to accomplish something*. In fact it would be more appropriate to assume that someone wants to accomplish something, *as long as it is in his or her interest*. In the paper, therefore, a more general project definition is introduced which is related to the interests of the participant's owners. All notations used in the paper are summarized in Table 1.

First, let us define value-driving parameter ($x_{n,t}$) as an arbitrary variable that can have any effect on the financial position of the owners of a business idea. The business idea is either to deliver a complete unique product, service, or result; or only to participate in creating it partially. $n = (1,...,N)$ refers to the physical indicators (see below), and $t = (1,...,T)$ refers to the time period under study (typically in years). Based on these two variables, the $CF_t = s(x_{1,t},...,x_{N,t})$ annual cash flow in year t can be determined, showing the expected change in the value of the owners' equity related to the business idea for that period.

Tab. 1. Notations

$x_{n,t}$ – a value-driving parameter, where $n = (1,…,N)$ refers to the nature of the parameter, and $t = (1,…,T)$ refers to the given time period in years.
CF_t – expected annual cash flow in year t.
r_{min} – minimum rate of owners' return requirement.
IRR – financial internal rate of return of a project.
ERR – economic internal rate of return of a project.
$E(r)$ – expected return of a project, which can be calculated by the internal rate of return function.
$E(r_p)$ – the expected return of the portfolio.
$E(r_n)$ – the expected returns of asset n.
$r(x_i)$ – rate of return in function of an arbitrary value driving parameter.
r_A – the minimum return requirement of the owners.
$\sigma(r_n)$ – the deviation of the returns of investment n.
$\sigma(r_p)$ – the deviation of the return of a portfolio.
$k_{i,j}$ – the correlation between the deviations of the returns of investment i and j.
β_n – the non-diversifiable risk of an investment.
L_t – cash balance in year t.
$DSCR_t$ – debt service coverage ratio in year t.
$B(x_i)$ – economic break-even point of an arbitrary value driving parameter.
$S(x_1)$ – the total number of a sample.
$s(x_1)$ – the number of times that s harmful event occurred in a sample.

Value-driving parameters can be typically the following:

- parameters that are necessary for the calculation of the cost of capital: long-term nominal risk-free return, market risk premium, unlevered or levered industrial sector beta, and debt beta (the beta of a stock, portfolio or debt is a number describing the correlated volatility of an asset in relation to the volatility of the market as a whole);
- taxes: corporate income tax, business tax, land tax, building tax, VAT, and other taxes;
- parameters of a potential loan: amount of the loan, base interest rate (often bound to a reference index), interest surcharge, other costs, spot exchange rates and expected inflation rates of relevant currencies);
- project-specific parameters (e.g., investment costs, components of expected operation costs and revenues, expected terminal value);
- parameters of unusual and acts of god situations (e.g. possible damage in environment, potential occupational safety and health damages, and unexpected penalties).

Now, the project can be defined as the series of expected values of cash flows calculated from the value-driving parameters of a business idea. Annual cash flows are uncertain expectations regarding the future, and can be specified only from the perspective of the owners of the actual business idea. Fig. 1 shows the expected cash flows of the genuine business idea owners.

As Fig. 1 shows, the later cash flows have a higher forecasting uncertainty that is illustrated by higher standard deviations.

Accordingly, it must be noted that in the traditional approach to risk management, often higher risks are found in the risk categories of the later periods, but this important phenomenon and its consequences have not been emphasized sufficiently in the project management literature.

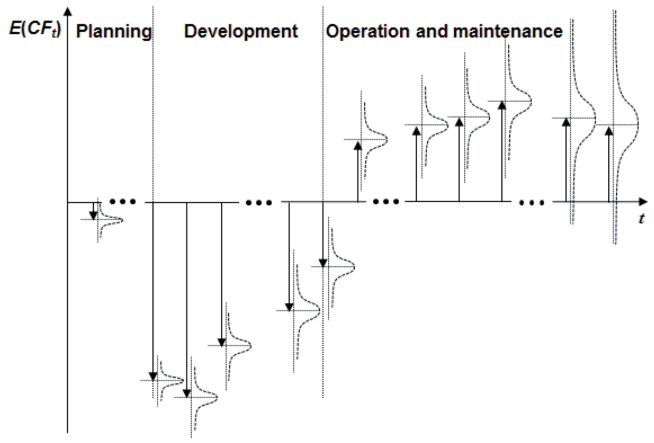

Fig. 1. Expected cash flow series of a business idea

The primary stakeholder of a project is the owner of a genuine business idea who is from either the private or public sector. Although financial assessment methods differ slightly in the two cases, the ultimate goal remains the same: to achieve higher benefits than costs. Although a discussion about the unique elements of public sector projects goes beyond the scope of this article, it has to be mentioned that the terms costs and benefits refer to the society as a whole in this case. Costs include the expenses of all resources, including financial capital. In other words, in the private sector the expected internal rate of return (*IRR)* and in the public sector the economic rate of return (*ERR)* of the business idea must be higher than the minimum rate of return requirement (r_{min}).

$$\begin{aligned} IRR &\geq r_{\min} \\ ERR &\geq r_{\min} \end{aligned} \tag{1}$$

Although the interests of the owners are clear, they rarely participate in the project implementation directly. They involve intermediaries that are specialized agencies in various legal forms representing the interests of owners. An agency can be a project company that is created especially to undertake the business idea, or a contractor, mutual fund, or creditor company. In this sense public investors are also agencies representing the interests of the public as the owner.

Figure 1 illustrates the total expected cash flows of the genuine business idea. Any participant in the process receives a share of these cash flows based on negotiated contract conditions. For example, the owners of a project idea or their agency may employ a contractor because they do not have a comparative advantage in managing the project (e.g., an innovation process or construction). The contractor company then is an agency which represents its owners' interests. In this case, the owner of the tender-winning contractor makes a profit by organizing construction in a more inexpensive and effective manner than expected by the owners of the project idea. It is also possible that the owners of a contracting company cannot or do not want to allocate financial capital to a project and thus share the available profit with a creditor. The creditor is also an agency and it makes a profit by creating liquidity for the project more inexpensively than is either possible for or expected by the contractor. In the same manner, the owners of the investment idea may also decide to involve a creditor to pay the contractor. Of course, the idea can be continued: the contractor may employ specialized subcontractors and may also share the available profit. In this case, the subcontractor makes a profit by organizing, for example, an engineering activity more inexpensively and effectively than the contractor can. An insurance company can also participate in the process and make a profit by being able to absorb risks better than the genuine business idea owners or the participating agencies. Continuing the interpretation, the expected cash flows of any participant agency can be identified.

In the figure below, the main phases of a general project are illustrated, in addition to the cash flows of the main participant agencies (Fig. 2).

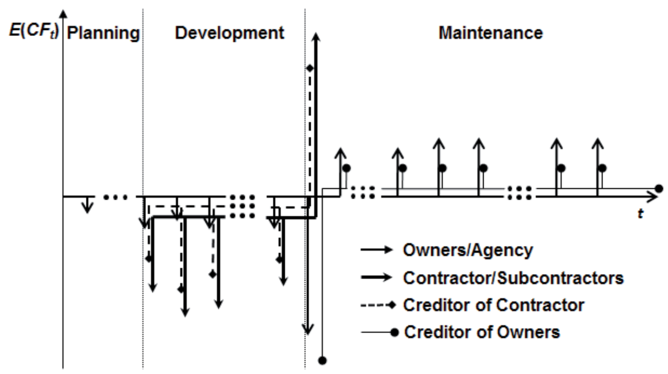

Fig. 2. Several participants share the expected cash flows of the genuine business idea

A project begins only when the participants are clearly aware of how they will share the cash flows and how much profit they can expect. As a direct consequence, realizing the expected profit is in the interest of all participants for a project that appears to be value creating ex-ante. That is why traditional project management may conclude that achieving the predefined time, cost, and quality parameters, which ensure expected profit, are the primary goals. But these are derived goals only in a very special situation, where everything happens as expected. However, deviations from expectations do not necessarily lead to unbearable situations, where the participants want to exit. Under traditional risk management concepts, mainly subjective methods are used for deciding what extent of deviation is considered unbearable in each risk category, because the ranking of the goals, the context among them, and the minimum requirements for them are undefined. Hence, it is a practical rule of thumb that when problems arise there are significant deviations from expectations. In such situations, the conditions of contracts among participant agencies determine who realizes the unexpected loss and who receives the unexpected profit. Thus, deviations from the traditionally derived goals cannot display the real risks of owners.

To describe a risk concept, which can deal with the above-mentioned problems, the minimum requirements of the owners must be clarified.

4 Minimum Requirements of Owners

To attain the minimum requirements of owners at project completion (i.e., to determine the point at which owners are still sufficiently motivated to undertake their projects), the owners' alternative choices first must be clarified. Obviously, the alternatives are the returns on the activities that can be achieved with the least effort. In the capital markets, a nearly indefinite number of possible investments are available in all types of business areas, and there are brilliant models for valuing them. These models are typically based on the risk-averse, rational behavior of owners and often result in owners sharing their savings among several investments. However, this behavior also has inevitable consequences for the field of project management, and the usual implicit assumption that the financial position of owners solely depends on the actual project is no longer relevant.

Based on Markowitz's portfolio theory (1959), risk-averse, rational individuals necessarily tend to hold portfolios. A portfolio may consist of not only financial products, such as shares in companies or debts; but also private investments, such as the acquisition of a degree or a home purchase; and other special private options.

The reason for holding portfolios is that on the one hand the expected return of the portfolio (r_p) of such individuals is equal to the weighted sum of the expected returns $E(r_n)$ of the constituent assets:

$$E(r_P) = \sum_{n=1}^{N} a_n \cdot E(r_n) = \overline{E(r_n)}$$
$$\sum_{n=1}^{N} a_n = 1 \tag{2}$$

where a_n is the weight of component asset n. On the other hand, because of the stochastic relationships ($k_{i,j}$) among the deviations of the returns of the investment opportunities ($\sigma(r_n)$), the deviation of the return of the portfolio ($\sigma(r_p)$) is generally less than the weighted sum of the deviations of the returns of the components:

$$\sigma(r_P) = \sqrt{\sum_{n=1}^{N} a_n^2 \sigma^2(r_n) + \sum_{i,j=1}^{N,N} 2k_{i,j} a_i \sigma(r_i) a_j \sigma(r_j)} \leq \overline{\sigma(r_n)} \tag{3}$$

Consequently, risk-averse investors tend to hold portfolios with more elements because they have relatively less risk. Therefore, when the riskiness of the return of a project as an investment is analyzed, a significant amount of its total risk (deviation of its return) is simply eliminated owing to the holding of a portfolio. The traditional risk management approach distributes the total risk of a project within the risk classes; as a consequence, the fact that only a fraction of the project's risks is assumed by the owners is ignored.

Thus, the following question arises: what is the extent of that fraction? Lintner (1965), Mossin (1966) and Sharpe (1964) have answered this question in their development of the capital asset pricing model (*CAPM*).

These authors assumed that owners extend their portfolios until they hold the so-called market portfolio, which represents all the investment opportunities in the market, and this portfolio can be combined with risk-free investments. The model has been created by assuming that all investors have identical knowledge of the world (their expectations are homogeneous). It can then be deduced that the relevant, non-diversifiable risk (β_n) of every element of a portfolio can be expressed as the function of the deviation of the market portfolio $\sigma(r_M)$, the expected return of the investment opportunity ($\sigma(r_n)$) and the correlation of the two parameters ($k_{n,M}$):

$$\beta_n = k_{n,M} \frac{\sigma(r_n)}{\sigma(r_M)} \tag{4}$$

According to traditional, commonly accepted wisdom, greater risk is associated with greater returns. This statement can be interpreted in view of the reasoning above: the relevant risk (β_i) that is assumed by the owner defines the word "risk". The capital asset pricing model quantifies this relationship:

$$r_n = r_f + \beta_n (E(r_M) - r_f) \tag{5}$$

where $E(r_M)$ is the expected return of the market portfolio and r_f is the return of the risk-free investment. When making investment decisions, owners determine their requirements concerning the expected return based on the beta of their business idea, which is often approximated by industry sector betas. A project that is expected to have higher returns than is possible from capital market investments with similar relevant risk will be launched; however, if the returns are not sufficiently high, the project will be rejected.

The *CAPM* has been investigated, specified, and challenged in numerous ways (e.g., arbitrage pricing theory, multi-factor models). While an overview of these increasingly precise models would extend beyond the goals of the present paper, it is sufficient to rely on risk-averse, rational owners holding portfolios in all approaches, and their minimum return requirement can thus be deduced.

Issues related to public investments must also be considered. Although the approach to the estimation of cash flow differs in this case, the calculation of minimum requirements is based on similar principles. E.g., Evans and Sezer (2005) gave a more detailed description that provides an approach to the calculation of the minimum social rate for the European Union.

5 Identifying Harmful Events

The above-mentioned concept has fundamental significance in project management: the primary aim of a project is to achieve a higher expected internal rate of return than is possible from capital market investments with similar relevant risk.

However, in some cases more typical financial bottlenecks can be identified:

If a project is undertaken by a company specifically founded for the implementation of this project, then project liquidity must also be maintained; that is, the cash balance (L_t) of the project must be positive in each year:

$$L_t = g(x_{1,t},...,x_{n,t},...,x_{N,t}) \geq 0 \qquad \forall t \in [0,T] \tag{6}$$

If the project is undertaken by a company with many projects, then this constraint is not so important - more precisely, maintaining the liquidity of the whole company is then the constraint, which is a company level resource allocation problem beyond this paper's scope.

If debt is also involved in financing the project, then the debt service coverage ratio ($DSCR_t$) cannot decrease below the value (C_t) that is specified by the loan contract in each year:

$$DSCR_t = v(x_{1,t},...x_{n,t},...,x_{N,t}) \geq C_t \qquad \forall t \in [0,T] \tag{7}$$

This bottleneck is an often-used heuristic rule of thumb by which creditors attempt to assure that borrowers will not succumb to bankruptcy. Absent these conditions, the ex post rate of return of a project can dramatically decrease as the transaction costs of a possible financial distress may be unexpectedly high in an imperfect world. Failing to satisfy this condition is also considered to be a harmful event.

The typical harmful events are as follows:

1. The expected internal rate of return or the economic internal rate of return is less than or equal to the minimum requirements of the owners.
2. The yearly cash balance is negative.
3. The yearly debt service coverage ratio is less than the specified value.

At this point, we depart from the traditional concepts of project management risk analysis. First, risks must be analyzed based on the owner's minimum rate of return requirements. Second, rather than risk classes, it should be focused on value-driving parameters or, more precisely, on how their effects influence the occurrence of harmful events. In other words, while traditional concepts try to assess the effects of, for example, political or environmental risks on the project completion, the integrated concept assesses the effects of value-driving parameters on the rate of return of the project. The modest role of political and environmental risks in this framework is to partially determine the distribution of the value-driving parameters.

The following section reconsiders some basic analytical methods that can be used in the course of the planning phase of projects for all agencies to assess the so called idiosyncratic risks that are not eliminated within the project owner's portfolio.

6 Assessment of Idiosyncratic Risks Introduction

The owners cannot diversify idiosyncratic risks, so assessing these risks makes sense. More precisely, the probability of occurrence of those risk components needs to be assessed, which causes a change different from market processes in the project's rate of return. For instance, a decline in the income of the project may come from a general market decline, which is not a relevant risk, since the minimum requirement of the owners also declines. The events causing these specific reasons sometimes can be easily defined - in this case a scenario analysis is applicable. Sometimes there are only obscure reasons that have impact on several value-driving parameters, and in such cases, a simulation can deliver valuable results.

In our approach, the first step in the risk assessment is to prepare the complete financial model of a project based on the functions of the value-driving parameters. After the planned processes of the project are modeled by functions, the expected value of all possible financial variables can be calculated based on these basic data (e.g., expected project return, annual cash flows, net income, liquidity, dividends, working capital needs, debt service, debt service coverage ratio). For simplicity, the internal rate of return (IRR) capital budgeting method, which is calculated from the cash flow to the owners, is used here, but the approach can be extended to any arbitrary capital budgeting technique.

$$E(r) = IRR(x_{1,1},...,x_{n,t},...,x_{N,T}) \tag{8}$$

Next, a sensitivity analysis can be used to improve the structure of the project. By changing each variable ceteris paribus, those value-driving parameters whose deviation decisively determines the deviation of the project's expected return are presented.

$$\begin{aligned} r(x_{i,t}) &= IRR(x_{1,1},...,x_{n,t},...,x_{N,T}) \\ x_{n\neq i,t} &= E(x_{n,t}) \\ &\forall i \in [1,N] \end{aligned} \tag{9}$$

With a frequently applied simplification for conducting a sensitivity analysis, the variables of the same nature vary with the same ratio in each year:

$$\frac{\Delta x_{i,1}}{x_{i,1}} = \frac{\Delta x_{i,t}}{x_{i,t}} = 1 + a_i \qquad \forall t \in [1,T], \quad \forall i \in [1,N] \tag{10}$$

Thus, in Fig. 3, $r(x_{i,t})$ is referred to only as $r(x_i)$. The critical value-driving parameters could be further analyzed; their estimations and calculations could be performed in a more precise and detailed manner for the project, and its contracts can be restructured.

The r_A margin, the minimum return requirement of the owners (the expected return of capital market investments with similar relevant risk), is highlighted in the diagram and shows how much the given parameter could change without causing the project's return to decrease below the acceptable minimum level. This value of a_i is the economic break-even point ($B(x_i)$) at which the return of the project ($r(x_i)$) is equal to the minimum requirements of the owners, ceteris paribus.

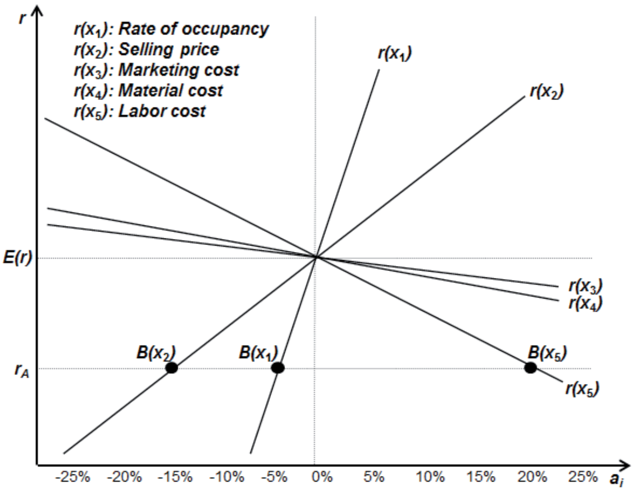

Fig. 3. Sensitivity analysis

$$r\big(x_i(1+B(x_i)\ \big)=r_A \tag{11}$$

Possessing information on the critical parameters is vital not only in the planning phase but also in the development and operation phases. More attention should be devoted to these components because they could be responsible for the poor performance of a project or, conversely, could increase profits. However, sensitivity analyses are suitable only for filtering the most significant parameters for the total risk of a project. To identify further consequences, one must determine the probability distribution functions of the value-driving variables using other methods.

If the probability density function of the occupancy ($f(x_1)$) is known, then by integrating over the minus infinity to the $B(x_1)$, one can determine the probability (P) that the value-driving variable is less than the break-even point. Thus, the variable deviates in the negative direction sufficiently to render the project as value-destroying.

$$P(-\infty < a_1 \leq B(x_1)) = \int_{-\infty}^{B(x_1)} f(x_1)dx_1 \tag{12}$$

If there is no continuous function available, for example, because the analysis of the process is empirical, then empirical probability is applied:

$$P(-\infty < a_1 \leq B(x_1)) = \frac{s(x_1)}{S(x_1)} \tag{13}$$

where $S(x_1)$ is the total number of the sample, and $s(x_1)$ relates to the number of times that the harmful event occurred.

Clearly, the analysis must be conducted for the occurrence of all other harmful events. Because a project company does not typically possess the competences that are necessary to manage risks other than project-specific risks, the project processes (e.g., the contracts with subcontractors, financing and dividend paying conditions) must be modified and re-planned until the probability of the occurrence of the value-destroying states becomes insignificant.

Eventually, the risks of a well-prepared project can be restructured until only the project-specific parameters remain.

Project-specific risks could theoretically also be covered, but doing this would not be appropriate because, according to the *CAPM*, without taking those risks, only the risk-free rate can be obtained (otherwise, arbitrage can be gained).

Sensitivity analysis reflects the likelihood of an average deviation from the expected value of specific parameters. If a value-driving parameter decreases 30 % for 3 years and then increases 30 % for 3 years, then sensitivity analysis signals nothing while the project may become bankrupt in the third year. Regarding the cyclicality of the economy, these possibilities are not uncommon. This type of risk can also be assessed with a Monte Carlo simulation.

A Monte Carlo simulation is basically suitable for estimating the likelihood of the occurrence of arbitrary events. All value-driving parameters are considered to be random variables in this technique, and the correlations (k) among them are also addressed. Random numbers are generated for the value-driving parameters fitted to their density function, the $DSCR_t$ and L_t in each year, and calculate the rate of return. When repeating this process many times, the frequency distribution of the variables can be outlined, and the probability of bankruptcy can be determined for each year (Fig. 4).

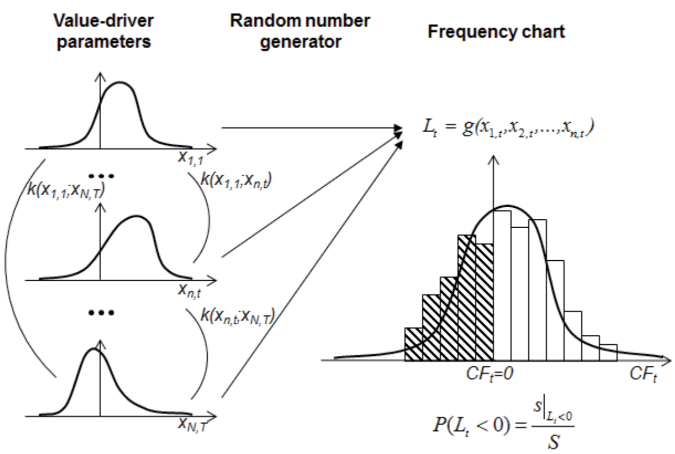

Fig. 4. Risk of default with simulation

The Monte-Carlo simulation can be widely applied to estimate the probability of any type of owner-specific events, such as the probability of the payment of a given amount of dividend in an arbitrary year or liquidity problems in the initial years of maintenance.

Risk assessment has a large pool of tools (for the more advanced methods, see, e.g., Karimi-Azari et al., 2011). A detailed description of these tools is far beyond the scope of the current paper. However, in our risk management framework, the aim of these tools is to determine the probability of the above-defined harmful events.

7 Discussion

In our approach, risk analysis is primarily a decision supporting tool, which helps define the conditions of the contracts among the players in the initial or planning phase. As a consequence, the ultimate aim of risk assessment is to clarify the extent to which it is profitable for the owners of individual players to participate in the game based on the negotiated contract conditions and the probability of reaching this turning point. Because contracts are imperfect and the phenomenon of limited liability exists, the effects of unexpected events are not a zero-sum game. If any player decides to exit from their project unilaterally (e.g., becomes bankrupt), then their action can also damage the other participants. Obviously, all participants strive to obtain optimal contractual positions, but risk assessment can assist in preventing any participant from securing a position in which the possibility of losing financial interest (and thus exiting) is overly high. With risk analysis, the probabilities of potential losses and gains can be estimated, along with who will realize them if they occur. Based on this assessment, contracts can be restructured until any risks without competitive advantage are reduced to an acceptable level. The critical situations, scenarios, proxy factors and break-even points can then be determined, and special action plans can be developed to save the profits or to minimize losses. Such action plans should contain the lossless transformation of project processes in the scenario or, if needed, the method for the consolidation of processes with the least amount of loss. Fig. 6 shows the result our proposed risk management process.

Another consequence we suggest for discussion is related to the process and purpose of risk identification and classification. In the integrated concept, risk identification and classification can be continuously used for the structured exploration of potential unexpected events and scenarios with some modifications. For instance, the category of country risk contains a special set of unexpected situations (e.g., the government tends to impose crisis taxes that reduce the income of the project; or in a country with a high probability of civil war, the assets of a project could be expropriated). In our approach, these possibilities have impact on the terminal value and tax value-driving parameters.

Time and cost overrun risks can be managed well with traditional project management tools. However, it should be noted that the traditional risk management methods of project management typically measure and manage only the downward deviation from a cost plan and the upward deviation from a time plan. In our opinion, cost or time overrun affects many value-driving parameters and can be considered themselves as special value-driving variables.

The third consequence we recommend for discussion is measuring project success and the related motivation-compensation fields. First, measuring the success of projects can be associated

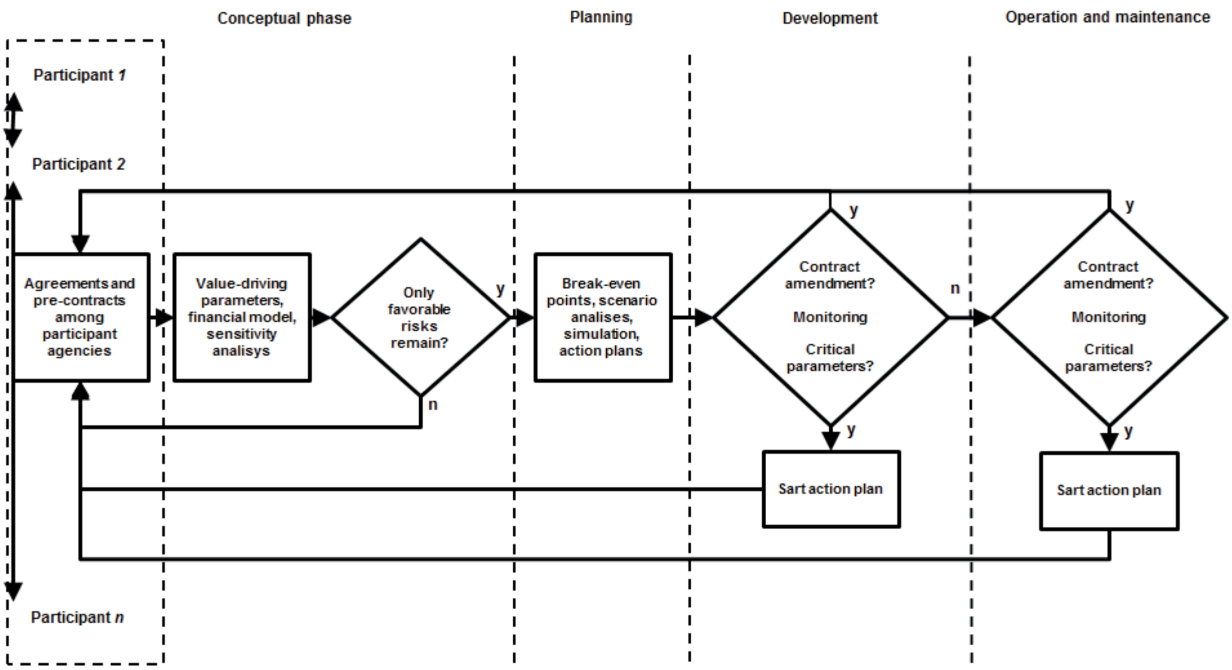

Fig. 5. Risk management process in the integrated framework

with the minimum requirements of the owners, which allows an objective measurement. Second, since the positive deviation from objectives is not interpretable in the traditional concept, there is no motivation by management to make such a deviation. However, in the integrated concept it is possible to launch a compensation program motivating the positive differences.

Our thesis is simple and clear: the goal of projects is to meet cash flow expectations. Therefore, the only project success criterion is the accomplishment of such cash flow expectations, and the project risks are those that threaten the fulfillment of this success criterion (for the latest findings on project success criteria and factors, see Cserháti – Szabó, 2014). Our proposed risk approach concentrates on achieving this cash flow; in contrast, the widespread risk analysis examines the accomplishment of technical parameters. In this sense, our approach is similar to the earned value management concept that is used in project monitoring and control, in which different technical dimensions are transferred into costs to facilitate a general comparison. By developing this line of thought further, one could establish a more complete and universal project management system that is able to connect separate sub-systems, such as investment valuation, risk management, monitoring and control. These thoughts are beyond the scope of this paper but are certainly deserving of further examination.

8 Conclusions

The current, widely known project management literature normally suggests that the total risk of a project should be classified into individual risk categories. Therefore, existing studies primarily focus on providing a full understanding of potential risk classes. The traditional literature does not cover the scalability of individual risk classes in detail (e.g., the acceptable degree of change) and does not provide methods for reflecting the fact that the predictability of later events in risk classes is more uncertain, which means that this approach does not take the time dependence of the riskiness of a risk category into consideration.

Simultaneously, a different concept was developed within the discipline of finance. Risks are divided into two groups: non-diversifiable and diversifiable risks. According to this approach, owners are indifferent to some of the risks that are considered in traditional project management. The two lines of research do not yet appear to have intersected with one another, although risk management is obviously the common subset of the two paradigms. This paper defined the aims and processes of risk management more precisely by merging the two paradigms. To ensure that risk management methods properly reflect the real exposure that is perceived by project owners, the foundations of a framework are established. The definition of project goals was extended to a more general determination that includes a financial concept. It is clearly established that the general aim of a project is to obtain an expected return that is greater than the minimum requirements of the owners; thus, the harmful event that owners may experience occurs when this condition is not satisfied. Further harmful events that typically occur in real estate development projects include credit defaults or decreases in the debt coverage ratio below the minimum requirement.

This paper also emphasizes that the participants (owners) share the total return on a business idea, which can be realized only if this business mechanism is in the interests of all of the players for the entire life cycle of the project.

Thereafter, the ultimate aim of risk assessment is defined, which is to assess the probability of the occurrence of the above-defined events that are harmful for various players. Based on this aim, contracts must be restructured until the risks without a competitive advantage are reduced to an acceptable level. Eventually, risk management must show the effects of the risks that are taken by the participant owners, and the action plans must be designed to account for those scenarios in which harmful events can occur.

The application of the suggested risk analysis approach provides deeper insight into the value-creating processes of projects, leads to higher added value compared with traditional methods, and provides a conceptual risk management framework for investment projects.

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